

5. On the Colour-Variation of the Beetle *Goniocтена variabilis*. By L. DONCASTER, M.A., F.Z.S.

[Received July 7, 1905.]

In 1895 (P. Z. S. 1895, p. 850) an account was given by Mr. Bateson of the colour-variation of *Goniocтена variabilis*, a Chrysomelid beetle. His material was collected almost entirely at Granada in the months of March and April; and he found that although the insect is extraordinarily variable, yet when a large collection is made the beetles could be classified into two chief groups with very few intermediates between them. The ground-colour of the elytra varies from a brilliant red through orange and buff to a greyish green; and although the intermediate colours (orange and buff) are comparatively rare, no sharp line between the red and green can be drawn. There is also a great diversity in the markings: some individuals, chiefly those with red elytra, have two black spots on each elytron (spotted type), others (almost exclusively greens) are without these spots but have rows of minute black dots (striped form), and a third class has both spots and stripes. A large series of figures is given in the paper referred to. Bateson further found that the spots and stripes have a definite relation to the sculpturing of the elytra; the spots having their centres on certain of the longitudinal rows of punctulations, while the stripes lie between them. The spotted or striped type may be associated with either the red or green colour, but Bateson observed that almost invariably the spotted elytra were associated with black pigmentation of the ventral surface of the abdomen, and that specimens with no spots had no black pigment in this position. The colour of the underside therefore provided a means of dividing a population into two classes with exceedingly few intermediates; some had dark undersides and spotted elytra (with or without stripes in addition), the remainder had light undersides and were without spots. When classified in this way, it is found that most of the dark-spotted specimens have red or reddish elytra, and most of the unspotted light are green; and further, that about 80 per cent. of the first class are males, and about 70 per cent. of the second class females. The males are easily distinguished from the females by the presence of a small rounded depression in the last uncovered abdominal plate; this is absent in the female.

In addition to the variations mentioned, there may be more or less suffusion of the elytra with black pigment, until a totally black form is reached. The specimens in which this melanic variation is not very pronounced show that they belong to the class which is both spotted and striped; it occurs much more frequently in red than in green individuals.

The case is of peculiar interest not only on account of the great variability in a single species, but especially because of the rather close correlation between the two chief colour-types and the two sexes. Bateson found that on the hills behind the Alhambra at Granada 80 per cent. of the males were spotted and dark below, and over 70 per cent. of the females unspotted and light. In the Darro valley, perhaps a couple of miles away, only 62 per cent. of the males were dark, and 85 per cent. of the females were light; *i. e.* there was a much higher proportion of light specimens in each sex. On the other hand, at Castillejo, near Toledo, rather early in the season, of 75 specimens all were dark and spotted, all but one being males. There was therefore some indication that the proportions vary with the locality, or possibly with the season; and it seemed important to determine whether the correlation between variation and sex was a genuine and permanent phenomenon, or was more or less accidental, depending on the local and seasonal conditions at Granada. I therefore took the opportunity, during a visit to Southern Spain this spring (1905), of collecting *Gonioctena* in various localities, in the hope of settling this question.

I found that *Spartium retama*, upon which the beetle lives, grew abundantly in most of the hilly uncultivated districts I visited, except in the neighbourhood of Gibraltar, where I imagine that the rainfall is too great, and in the desert to the east of the Sierra Nevada, which is almost wholly without vegetation. Almost everywhere where I found the *Spartium* I found also *Gonioctena*, but never saw it on any other plant. Where the beetles were abundant they were beaten into a net, but when they were scarce it was necessary to search carefully for them and catch each one separately. This probably leads to a slight excess of reds in my samples, since they are much more conspicuous; but when this method was adopted the bushes were searched very thoroughly, and I believe that the error may safely be disregarded. On one occasion one method was used in a particular locality, and two days later the other was tried in the same place; and the difference in the proportions of red and greens was not more than about 3 per cent., which might easily have been due to chance in a comparatively small sample.

I collected the beetles at Ronda, Granada, and in two or three localities in the neighbourhood of Malaga; those at Ronda were obtained on March 23-24, at Granada March 25 and 28, and collections were made at Malaga at the beginning of April and again towards the end of the month. It will be most convenient to describe the Granada collection first. On the hills behind the Alhambra, between the Genil and Darro valleys, *Gonioctena* was exceedingly abundant, and I collected altogether 1382 specimens, 978 males and 404 females (Table I.). In the distribution of the different varieties they agree remarkably closely with those obtained by Bateson ten years ago in the same place. Bateson

found that of the males 81 per cent. were spotted with dark undersides, 19 per cent. striped only with light undersides. I found rather over 83 per cent. spotted and dark, 16 per cent. striped and light, and about 0.5 per cent. with intermediate undersides. Of the females, I found 27.5 per cent. with dark undersides, the same proportion as was observed by Bateson. The occurrence of the different varieties is in every way in close agreement with that found by Bateson; and it may be concluded that their distribution at that season has not changed appreciably in ten years. I did not collect in the Darro valley from which Bateson's second sample was obtained, but I found that on the lower slope of the hill towards the Genil valley the proportions did not differ from those on the top. On the Darro slope of the hill, which is very steep and faces north, the beetle did not occur, although *Spartium* was abundant.

At Granada a considerable proportion of the beetles were *in cop.*, and I collected 119 couples and recorded the characters of each as they were gathered. Care was taken to see that they were really paired, and since 71 pairs remained coupled after they were dead in the killing-bottle, there can be little doubt that all or nearly all were really *in cop.* Table II. gives an analysis of these. Of the 119 pairs, there were 22, or over 18 per cent., in which both male and female were striped green with light undersides. Taking pairing at random among the general population the expectation would be 10.5 per cent. But the proportion of males of this type which were paired is considerably higher than in the general population (29 out of 119 or 24.4 per cent.); so that random mating out of those paired would give 17 per cent. of such pairs, which does not differ greatly from the 18 per cent. observed. Similarly there were 25 pairs (21 per cent.) in which both male and female were red with dark undersides. The expected number on random mating among the whole population is 15.2 per cent., on random mating among those actually found paired about 17 per cent. The numbers observed are of course much too small to give reliable conclusions, but they indicate that of the males of the green striped form, and females of the red spotted form, a slightly higher proportion is found paired than in the general population, and that there is possibly a very small tendency towards selective mating between individuals of the same colour type.

At Ronda *Spartium* bushes were very scarce, and upon many there were no beetles, so that altogether only 106 individuals were obtained, 80 of which were males, 26 females. Although these numbers are small, they indicate that the population differs considerably from that of Granada (Table III.). Of the males 60 (75 per cent.) were spotted and dark underneath, 9 were green, striped and light, one red, spotted and striped, light, and 10 red, spotted and striped, with intermediate undersides. At Granada only 6 intermediates occurred in 1382 specimens; while

at Ronda over 12 per cent. of the males, and one female out of 26, were classed as such. The females also differed greatly from the Granada population: out of 26 only 10 were green striped with light undersides, one was red, spotted and striped and intermediate, and 15 were spotted and dark below. Even this small collection indicates that the proportion in which the different forms occur varies widely according to locality, as was suggested by Bateson's collections in two areas very near together at Granada, and the entirely different type which he found at Castillejo.

The only other collections which I was able to make came from localities in the neighbourhood of Malaga, and these differ very greatly not only from those of Granada and Ronda, but from one another. In the first few days of April I collected on the hills round El Palo, a village on the coast some three miles east of Malaga. *Spartium* bushes were not very abundant and the collection is not large. All the beetles were obtained in an area not more than two miles in length, extending from near the sea to less than a mile inland, and nearly all were found at heights from 20 to perhaps 200 feet above the sea. In some places higher up the hills, *Spartium* was common but the beetles exceedingly scarce. A summary of this collection is given in Table IV *a*, and it is seen that out of 173 males 141 (81.5 per cent.) were of the green striped form with light undersides, the remainder being mostly red, spotted with no stripes, and dark below. Of 204 females 187 (91.6 per cent.) were green, striped and light underneath, so that the percentage of this form does not differ greatly from that found among the males. It is important to notice that two of the males and one female included in this class were pure green with no spots or stripes. It is also noticeable that in this locality the females were more numerous than males.

During the same days I made collections in two localities to the north of Malaga. One of these was at a place some three miles up the main road, perhaps 500 feet above the sea. Here I obtained 322 males and 197 females (Table V *a*). Of the males with light undersides, 98 were green striped (9 of them having also spots), 3 red striped, 18 red spotted and striped, and one pure green, giving 120 or about 37 per cent. of light undersides. There were 16 with intermediate undersides, and the remainder were red spotted and dark underneath, mostly without stripes. Among 197 females, 52 (about 26 per cent.) were light underneath, all being green, and there were only two with intermediate undersides. At this place, therefore, the proportions of the different colours were entirely different from those of Palo, although the two places are not more than 5 miles apart; and the percentage of light undersides was actually lower in the females than in the males.

I also made a very small collection on some bushes growing in

the river-bed about two miles above Malaga, *i. e.* about a mile from the place just mentioned, but only a few feet above sea-level. There were only 25 males and 39 females (Table VI *a*), but they are of interest partly on account of the preponderance of females, and partly because the proportions closely resemble those shown in Table V., although the beetles were obtained from near sea-level, *i. e.* at the same kind of altitude as those from Palo. In this collection there were no plain greens.

On April 7 collecting was interrupted for nearly three weeks, but on April 25 and 27 I was able in the short time at my disposal to obtain 23 males and 33 females at Palo (Table IV *b*). These numbers are too small to make possible a close comparison with the earlier gathering, but they are of importance from the fact that 12 of the males and 14 of the females were of the pure green type, usually with a yellowish tinge and nearly always brighter in colour than the green striped form. At the beginning of the month only 3 specimens of this type occurred in a collection of 377.

On the 26th I visited the bushes up the river-bed and gathered 23 males and 31 females (Table VI *b*), which included 4 males and 9 females of the pure green type, the proportions among the remainder being similar to those found on April 6. And on the 28th I obtained 40 males and 47 females from the road to the north (Table V *b*), and here again the plain green type was frequent, while three weeks before it had been almost absent.

When I first arrived at Malaga I found that a beetle larva was common on the *Spartium*, and a couple which I kept alive both hatched to the pure green form of *Gonioctena*. It occurred to me that the green type might develop black pigment later, but several which I kept alive for a week showed no change of colour. Finally, when I was about to return to England, I gathered a quantity of larvæ in the hope of bringing them back alive; some of these came from Palo, where the predominant type was green, others from the north road locality, where the majority were red. The greater part died on the voyage, but I reared to maturity three of the Palo batch and eleven from the north road, and every one of these was plain green. There were 4 males and 10 females.

I thought at Malaga that possibly the plain green type belonged to another species; and I attempted to find out whether it ever paired with the other forms, but was not successful. Very few, however, were pairing at that time, so no importance can be attached to the fact that I never found the two types paired together.

On my return to England, Dr. Sharp very kindly examined some specimens of the green form and compared them with the spotted red, and reported that he believed they belonged to the same species. It must be concluded that as the season advances a new type begins to appear, and, judging by the fact that all the

larvæ which hatched yielded this form, it probably replaces the other varieties altogether.

A possible explanation of the meaning of this seasonal change occurred to me, when I noticed that the plain green form only appeared when the bushes began to come into bloom. Bateson has pointed out how close a resemblance the green striped form has to the grey-green of the *Spartium* twigs, and suggested that the resemblance might be regarded as protective. So also the red spotted type has a marked general similarity to the common *Coccinella septempunctata* which frequently occurred on the *Spartium*; so that the red type of coloration may perhaps be considered as mimicry of a species protected by its unpleasant odour. But more close than either of these is the resemblance of the plain green type to the flowers of the *Spartium*. The flowers are very small and grow in clusters; the petals are yellow, but are partly covered by the bright green calyx. When a bush is in full bloom the plain green type of beetle becomes almost invisible; its thorax is yellow corresponding with the yellow petals, and its elytra have nearly the same colour as the calyx. The general resemblance is so close that the beetles are very hard to see when the bush is in bloom, although when they are found on a plant which has not come into flower they are nearly as conspicuous as the red type.

My observations, taken as a whole, lead me to the conclusion that the correlation between the two main forms of *Gonioctena* and the two sexes, which Bateson observed at Granada, is a special phenomenon depending partly on locality and partly on season. At Ronda the correlation was much less conspicuous, and at Malaga it did not exist. Further, it appears that the frequency of the different varieties depends largely on season, but my observations did not extend over a long enough period to work this out thoroughly. At the higher, and presumably more backward, localities the males were more numerous than the females, and the red spotted type was most abundant; this was most conspicuously the case in Bateson's collections from Castillejo. Near sea-level there was an excess of females, and at Palo this was associated with a predominance of green. Finally, as the season advanced and the *Spartium* came into bloom, a pure green type appeared; and from the fact that no other form hatched from the larvæ which I collected, it seems probable that in the summer this is the predominant type of both sexes.

In conclusion, I wish to acknowledge my indebtedness to my brother for much valuable help in collecting the beetles.

Zoological Laboratory, Cambridge,
July 1905.

[In the tables reference is made to the figures given by Bateson,
P. Z. S. 1895, plate xlvii.]

TABLE I.—Collection made at Granada, March 25–28.

Description.	Males.		Females.	
	Col-lected.	Per-cent.	Col-lected.	Per-cent.
A. Dark undersides.				
Red, spotted (Bateson's figs. 1, 2, 3, 14, 19)	674	69	50	11
Green, spotted (B., figs. 4, 5, 6, 13)	34	3·5	23	6
Red, spotted and striped (B., figs. 7, 8, 30)	77	8	17	4
Melanic reds (B., figs. 10, 11, 12)	28	3	19	5
Green, spotted and striped (B., figs. 27, 28)	4	0·5	6	1·5
Total dark undersides	817	84	115	27·5
B. Intermediate undersides.				
Red, spotted and striped	2	0·5	1	
Red, spotted	1			
Green, spotted and striped	2			
Total intermediate	5	0·5	1	
C. Light undersides.				
Green, striped (Bateson's figs. 22, 23)	149	16	274	68
Green, spotted and striped (B., figs. 25, 27, 28)	7		14	3·5
Total light undersides	156	16	288	71·5
TOTAL	978	100·5	404	99

TABLE II.—Couples recorded at Granada, March 28.

Description.	Total recorded as gathered.	Remained coupled after death.	Description.	Total recorded as gathered.	Remained coupled after death.
♂ } red, spotted, dark	17	10	♂ green, spotted, dark ... }	3	2
♂ } red, spotted	6	2	♂ green, striped, light ... }		
♂ } red, melanic			♀ red, spotted, dark (one melanic) ... }	3	1
♂ } red, spotted, dark ... }	4	3	♂ green, striped, light ... }	4	3
♂ } green, spotted, dark ... }			♀ green, spotted, dark ... }		
♂ } red, spotted (one melanic) ... }	58	40	♀ } green, striped, light ... }	22	9
♀ green, striped, light ... }					
♀ red, melanic	2	1	TOTAL	119	71
♀ red, spotted & striped }					

TABLE III.—Collection made at Ronda, March 23 and 24.

Description.	<i>Males.</i>		<i>Females.</i>	
	Col- lected.	Per cent.	Col- lected.	Per cent.
A. Dark undersides.				
Red, spotted (Bateson's figs. 1, 2, 19)	46	...	12	
Red, spotted and striped (B., figs. 7, 8, 16)	11	...	1	
Green, spotted (B., figs. 4, 5, 28)	3	...	2	
Total dark undersides	60	75	15	58
B. Intermediate undersides.				
Red, spotted and striped (B., figs. 7, 16, 30) ...	10	12·5	1	4
C. Light undersides.				
Red, spotted and striped (B., fig. 7)	1			
Green, spotted and striped (B., figs. 27, 28)	2	...	4	
Green, striped (B., figs. 22, 23)	7	...	6	
Total light undersides	10	12·5	10	39

TABLE IV.—Collections made at Malaga (El Palo).

IV *a* on April 1, 2, 4, 7. IV *b* on April 25 and 27.IV *a*.IV *b*.

Description.	<i>Males.</i>		<i>Females.</i>		<i>Males.</i>		<i>Females.</i>	
	Col- lected.	Per cent.	Col- lected.	Per cent.	Col- lected.	Per cent.	Col- lected.	Per cent.
Red, spotted, dark	25	...	9	...	1	...	2	
Red, spotted and striped, dark	7	...	5	...	...	...	1	
Total dark	32	18·5	14	7	1	4	3	9
Red, spotted and striped, intermediate	...	...	2	1				
Green, spotted and striped, light	...	...	1					
Green, striped, light	139	80·5	187	91·5	10	43	16	48
Plain green, light	2	1	1	0·5	12	52	14	42
Total light	141	81·5	189	92	22	95	30	90
TOTAL	173	100	205	100	23	99	33	99

TABLE V.—Collection made 3 miles north of Malaga.

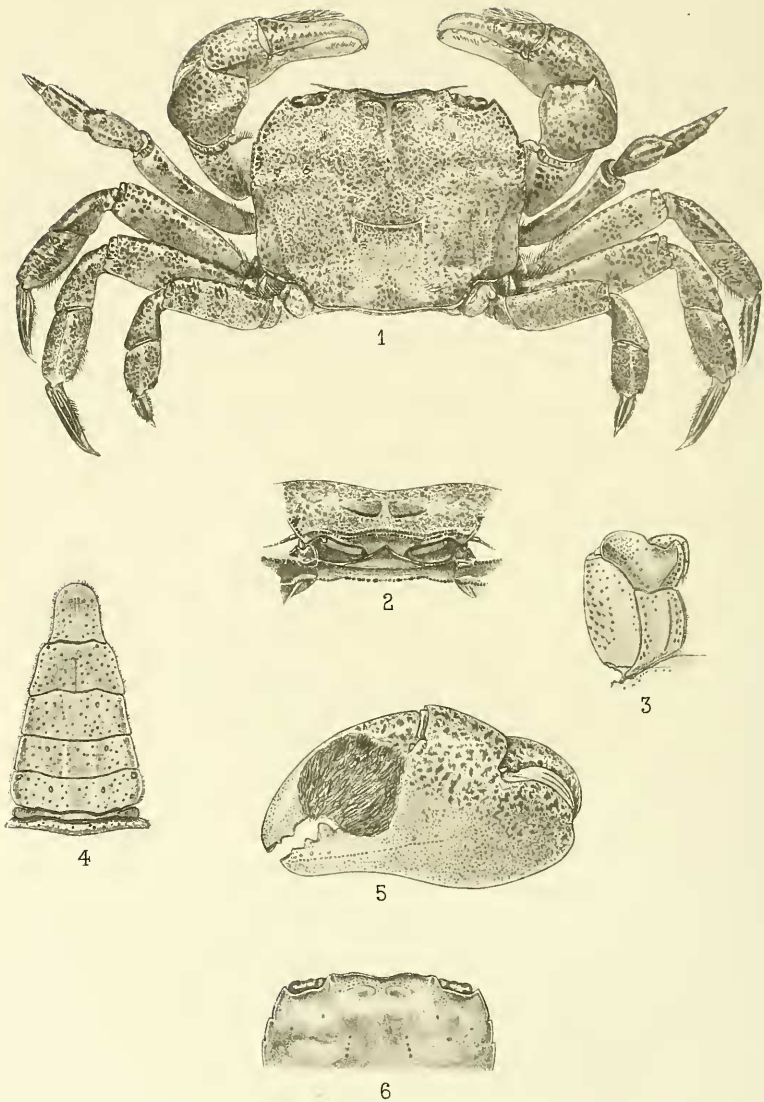
V *a* on April 3 and 5. V *b* on April 28.V *a*.V *b*.

Description.	Males.		Females.		Males.		Females.	
	Col- lected.	Per cent.	Col- lected.	Per cent.	Col- lected.	Per cent.	Col- lected.	Per cent.
A. Dark undersides.								
Plain red	1							
Red, spotted (Bateson's figs. 1, 2, 3)....	166	...	114	...	17	...	15	
Red, spotted and striped (B., figs. 7, 8)	19	...	27	...	2	...	8	
Red, melanic (B., figs 9, 10, 11)	...	...	2					
Total dark	186	58	143	72.5	19	48	23	49
B. Intermediate undersides.								
Red, spotted and striped (Bateson's figs. 7, 19, 30)	16	5	2	1				
C. Light undersides.								
Red, spotted and striped (Bateson's figs. 7, 19, 30)	18	...	...	...	2	5		
Red, striped (B., figs. 20, 21)	3							
Green, spotted and striped (Bateson's figs. 27, 28)	9	...	1					
Green, striped (B., figs. 22, 23)	89	...	50	...	12	...	12	
Plain green	1	...	1	...	7	...	12	
Total light	120	37	52	26.5	21	52	24	51
TOTAL	322	100	197	100	40	100	47	100

TABLE VI.—Collection made in river-bed, 2 miles above Malaga.

VI *a* on April 6. VI *b* on April 26.VI *a*.VI *b*.

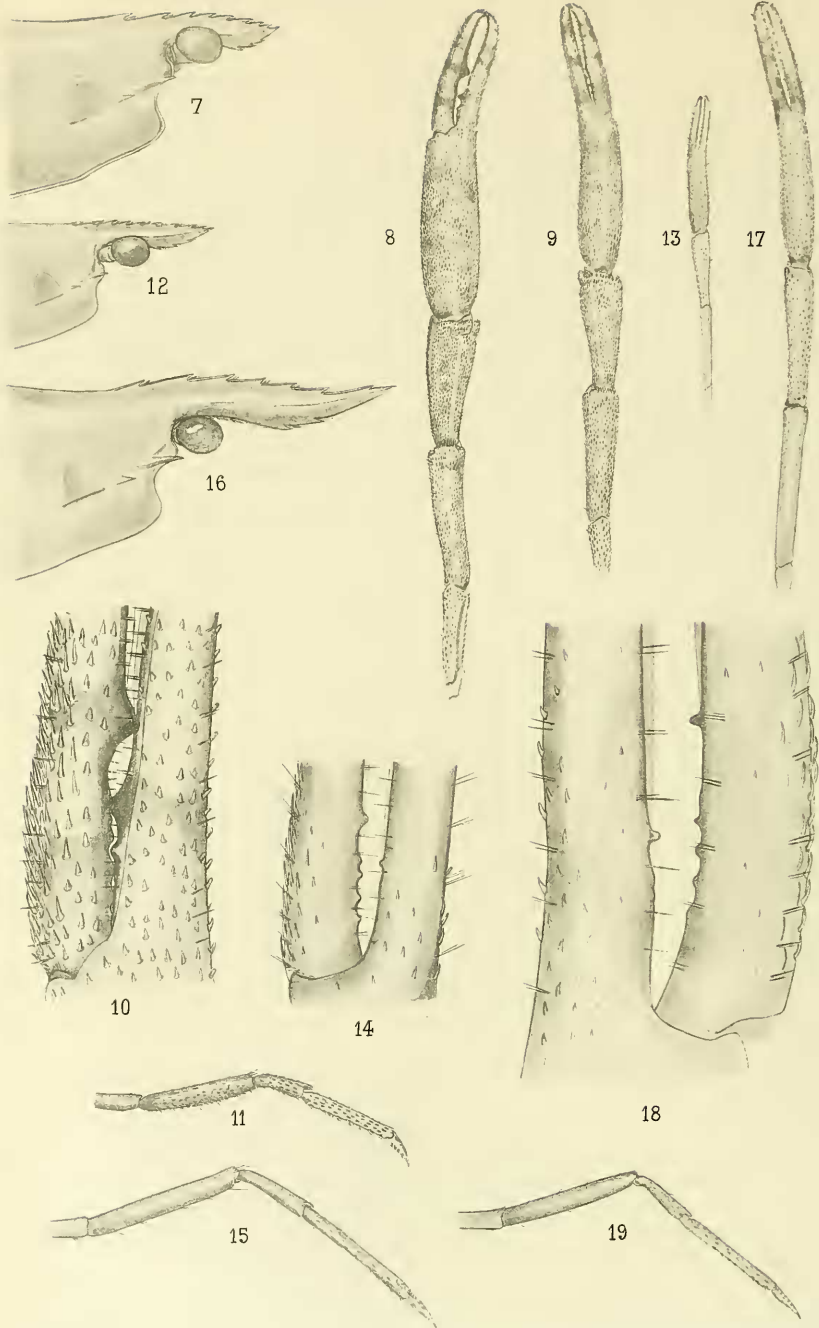
Description.	Males.		Females.		Males.		Females.	
	Col- lected.	Per cent.	Col- lected.	Per cent.	Col- lected.	Per cent.	Col- lected.	Per cent.
Red, spotted, dark	16	...	29	...	11	...	6	
Red, spotted and striped, dark	...	...	6	...	2	...	8	
Total dark	16	64	35	90	13	56	14	45
Red, spotted and striped, intermediate	2	8	...	...	1	4	1	3
Green, striped, light	7	28	4	10	5	23	7	23
Plain green, light	...	...	...		4	17	9	29
Total light	7	28	4	10	9	40	16	52
TOTAL	25	100	39	100	23	100	31	100



J.G.de Man.del.

Bale & Danielsson Lit. Photogravure.

1-5. *PTYCHOGNATHUS PUSILLUS*.
6. *P. BARBATUS*.



J. G. de Man. del.

Bale & Danielsson LH Photogravure.

7-15, PALÆMON (EUPALÆMON) LAR. VAR.

16-19, P. (EUPALÆMON) LAR.

6. On Species of Crustacea of the Genera *Ptychognathus* Stimps. and *Palæmon* Fabr. from Christmas Island.
By Dr. J. G. DE MAN, of Ierseke, Holland.

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(Plates XVII. & XVIII.*)

The Crabs and Prawns described in this paper were sent me for examination by Dr. W. T. Calman, of the British Museum. They were collected by Dr. R. Hanitsch, of the Raffles Museum, Singapore, who wrote to Dr. C. W. Andrews regarding them: "The Prawn and the Crab were obtained from a small, artificial freshwater pool, on Christmas Island, above the waterfall, which probably did not exist in your time [*i. e.* when Dr. Andrews was on the island in 1897-1898]." Dr. Andrews adds that at the time of his stay on the island the stream in question was a very small thread of water, trickling down the precipitous hill through thick bush, without pools of any size or depth, and that he carefully explored it for Crustacea without finding any. Of course it is just possible that they may have existed in some pools not visited by him.

PTYCHOGNATHUS PUSILLUS Heller. (Plate XVII. figs. 1-5.)

Ptychognathus pusillus Heller, Crustaceen der Novara Reise, 1865, p. 60.

Ptychognathus pusillus de Man, in Zoolog. Jahrb. (Spengel), vol. ix. 1895, Abth. f. Syst. p. 99, Taf. 28. fig. 22.

One male and one female without eggs from a freshwater pool on Christmas Island.

Ptychognathus pusillus Heller was founded, forty years ago, on a single female specimen collected by the 'Novara' Expedition on the Nicobar Islands; Heller did not figure his species. A new, detailed description, illustrated by several figures, of this type-specimen, preserved in the Museum of Vienna, appeared in 1895 in my paper on the Decapod Crustacea gathered by Captain Storm in the Indian Archipelago: I suggested in this description that *Ptychognathus pusillus* should be regarded either as a distinct species, the male of which was still unknown, or as a young individual of another known species, perhaps *Ptych. pilipes* A. M.-Edw., from Celebes, or *Ptych. intermedius* de M., from the Moluccas (*l. c.* p. 100). *Ptychognathus pusillus*, however, apparently a rare freshwater crab, has not been met with during the long period of forty years, and its rediscovery on Christmas Island is therefore particularly interesting, especially because not only the female was found, but also the male, which hitherto was unknown. The two specimens prove that *Ptych. pusillus* Heller is a "good species," different from all its congeners.

* For explanation of the Plates, see p. 550.

The female from Christmas Island is of a somewhat larger size than Heller's type specimen; the measurements are the same, except that the greatest width of the carapace of the female from Christmas Island is a little larger in proportion both to the length of the carapace and to the distance between the external orbital angles. The exognath of the external maxillipedes, though still less broad than the ischium-joint, appears broader in proportion to this joint than in Heller's younger type specimen, and the chelæ are comparatively larger. The tips of both fingers carry some stiffish hairs on their outer surface close to the horny border; these hairs are more numerous on the tip of the fixed finger. In the Vienna type specimen these hairs were, no doubt, worn off. The dactylus carries 6 or 7, acute, conical teeth, and the fixed finger 4 or 5, which are a little larger. These slight differences are caused by the larger size of this specimen, which, for the rest, fully agrees with Heller's type. The male is larger than the female and more than once and a half as large as Heller's type specimen; regarding the proportion of the measurements of the carapace, the male agrees with the female from Christmas Island. The cephalothorax also fully agrees in its other characters with my description of 1895, except as regards the outer footjaws. I suggested in that paper that, in the male, the exognath should be as broad as or perhaps even a little broader than the ischium-joint; this supposition is now confirmed by the male from Christmas Island. In this male, indeed, the exognath (Pl. XVII. fig. 3) appears *a little broader* than the ischium, the proportion between them being as 11:10; the exognath is distinctly convex longitudinally and also a little transversely. The merus-joint fully agrees with that of the type specimen, its antero-lateral angle being rounded, whereas the external margin, so far as it is contiguous to the exognath, appears very slightly concave; the outer half appears, under a lens, finely granulate. The exognath is somewhat punctate, except on the inner border and posteriorly, as is also the endognath, except in the middle, and short stiff setæ are inserted on the puncta. The abdomen (fig. 4) resembles that of *Ptych. polleni* de M. from Madagascar (de Man, l. c. Taf. 28. fig. 20 b), as is proved by the figure and the measurements. Sternum and abdomen are punctate; the 3rd, 4th, and 5th segments of the abdomen, counting from the base, carry, moreover, each a larger pit on their antero-lateral angle and another on the anterior half at either side of the middle line.

The chelipedes are equal (fig. 1). The punctate, anterior surface of the ischium carries one or two short, stiff setæ. The upper border of the merus is hairy on its proximal half, the obtuse anterior border is granular and a little pubescent proximally. The upper surface of the carpus is closely, but finely punctate, the rest smooth, but it appears finely granular under a lens in the female; the internal angle is obtuse, though not rounded. The chelæ (fig. 5) resemble *closely* those of *Ptych. barbatus*, not only as regards their general shape but also because

the fingers are provided, *each*, exactly as in that species, *with a tuft of hair*; the chelæ also much resemble those of *Ptych. pilipes* A. M.-Edw. from the Philippine Islands, but here the tufts of hair are wanting. Measured horizontally, the chelæ appear just as long as the distance between the antero-lateral angles of the carapace; the palm is a little shorter than the fingers and, at their articulation, a little higher than long. The convex, outer surface of the palm, under a lens, appears very finely, but closely, punctate, though smooth to the naked eye; both the upper and the lower borders are rounded. The somewhat curved, tapering dactylus carries 7 or 8 small teeth, which are rather obtuse, except two or three near the tip; the immobile finger has 5 or 6 more conical teeth, which are larger than those of the dactylus, especially two or three in the middle. The fingers are finely and closely punctate, just like the palm; on the middle of the outer surface of the fixed finger the puncta are arranged in a longitudinal row that extends from the tip almost to the middle of the palm; a few larger, impressed puncta occur on the distal half of the index just above that row. As in *Ptych. barbatus*, each finger carries a *close tuft of brown woolly hairs* on the proximal half of its outer surface; the tuft of the dactylus does not extend on to the upper border of the finger, and that of the fixed finger reaches only halfway between the teeth and the lower border. The tips of the fingers have horny margins: on the outer side of the tip of the fixed finger, close to and parallel with the horny edge, are seen a few short, stiffish setæ, though much less numerous than in the female; on the tip of the dactylus they are perhaps worn off. The inner surface of the chelæ (palm and fingers) is smooth and glabrous.

The ambulatory legs are hairy on the upper side of their basal joints, and a few stiff setæ occur on the lower surface of ischium and merus on either side of the articulation between these joints; the posterior border of the last two joints is also setose, and rows of short setæ occur on the lower side of the propodites of the 1st and 2nd pair. For the rest, the upper and the lower borders of these legs are *glabrous, devoid of the long hairs* that are characteristic of *Ptych. pilipes* A. M.-Edw. The meropodites appear under a strong lens very finely granular, except those of the last pair, which are almost smooth and only punctate; the puncta are small and numerous, but three or four larger puncta in a longitudinal row are found on the middle of the meropodites of the last pair. Just as in *Ptych. barbatus* A. M.-Edw., there is *no* subterminal spine on the anterior border of the meropodites. The following joints are also punctate, and the dactyli are ridged longitudinally both on the upper and lower sides.

On a yellow ground-colour the upper surface of carapace and legs is marked with innumerable, small, irregular spots of a dark purple colour, which on the epigastric and protogastric regions are almost confluent.

Among the twelve species of *Ptychognathus*, certainly *Ptych.*

barbatus A. M.-Edw. *, a marine crab from New Caledonia, which has also been observed on the shores of Atjeh, Penang, and of the islands between Japan and Formosa, is the most closely related form. As regards the proportion between the length of the carapace and the greatest width of it in adult specimens, both species fully agree with one another, but in young individuals the carapace of *barbatus* is slightly broader in proportion to its length than that of *pusillus* (de Man, *l. c.* p. 104). At all ages, however, both in the male and in the female, the cephalothorax of *barbatus* is anteriorly distinctly broader in proportion to its length, as is proved by comparing the measurements of the length of the carapace and of the distance between the extraorbital angles; the extraorbital teeth run therefore more obliquely with regard to the median line of the carapace in *Ptych. pusillus* than in *Ptych. barbatus* (figs. 1 and 6). In proportion to the greatest width of the carapace the front appears a little broader in *barbatus*; it has the same form in both species, but the granulated line that runs immediately behind the frontal margin is, in the middle line of the carapace, contiguous to that margin in *barbatus*, whereas in Heller's species (fig. 2) both lines are distant from one another in the middle. In *Ptych. barbatus* the epigastric lobes are situated farther from the frontal border than in *pusillus* (figs. 1 and 6). In *Ptych. barbatus* the 2nd and the 3rd antero-lateral teeth of the carapace are more salient and the incisions are deeper than in *pusillus*; near the antero-lateral teeth the carapace of *pusillus* is somewhat granulated, but in *barbatus* not.

The exognath of the external maxillipedes of the adult male of *Ptych. barbatus* is one-third broader than the ischium, and in the adult female it is just as broad or even very slightly broader than the ischium; in the adult male of *pusillus* the exognath appears a little less broad in proportion to the ischium, and in the female the ischium is decidedly broader than the exognath.

The slight differences exhibited by the legs are of little importance. But for a few hairs on the outer side of the tip of the fixed finger in the female, the extremities of the fingers of *barbatus* are glabrous. *Ptych. barbatus* is smaller than *pusillus* and the habitat is different, the former being probably a marine species, the latter a freshwater one.

An adult female of *Pseudograpsus barbatus* Rumph from the River Wukur, on the island of Flores, is lying before me (*vide* de Man, in Max Weber's 'Decapoden des Indischen Archipels,' 1892, p. 317); it will be useful to indicate the differences between this specimen and the female of *Ptych. pusillus* Heller, since they much resemble each other. Both species, of course, differ at first sight by their external maxillipedes; the rounded antero-external angle of the merus-joint is less strongly produced in *Pseudograpsus barbatus* than in Heller's species, and the exognath

* *Ptych. barbatus* is also described in Prof. Alcock's work: "Materials for a Carcinological Fauna of India.—No. 6. The Brachyura Catometopa or Grapsoidae," Journ. Asiatic Soc. Bengal, lxxix. (2) no. 3, 1900, p. 406.

of the former is, in the middle, only *half as broad* as the ischium, whereas it narrows more anteriorly. The epistome has a different form : in *Ptych. pusillus* it is barely broader laterally than in the middle, but in *Pseudogr. barbatus* the posterior margin is strongly arcuate, so that the epistome appears much broader laterally than in the middle. The legs are much alike in both species, but in *Pseudogr. barbatus* the last three joints of the ambulatory legs are *much more tomentose*. *Pseudogr. barbatus* finally attains a *larger size*.

Measurements of the two specimens of *Ptych. pusillus* Heller from Christmas Island, in millimetres.

	♂.	♀.
Distance between the antero-lateral angles of the carapace	13·5	10·5
Distance between the second teeth	17·5	13·25
Distance between the third teeth, <i>i. e.</i> the greatest breadth of the carapace	18	13·75
Breadth of the carapace at the posterior end of the lateral margins	17	13
Length of the carapace, in the middle line ...	14·5	11·5
Breadth of the frontal border	7·2	5·5
Breadth of the posterior border of the carapace	7·5	6
Breadth, in the middle, of the ischium-joint of the external maxillipedes	2	1·5
Breadth, in the middle, of the exognath	2·2	1·3
Horizontal length of the chelæ	13·5	6·5
" " " palm	6	3
Height of the palm, at the articulation of the fingers	7·75	3·3
Length of the antepenultimate joint of the abdomen, measured in the middle	2·1	
Length of the penultimate joint.....	2·1	
Breadth of the posterior border of this joint...	4·12	
" " anterior " " " ...	2·7	
Length of the terminal joint	2·6	

REVISION OF THE GENUS *PTYCHOGNATHUS* STIMPS.

The genus *Ptychognathus*, created by Stimpson in 1858 (Proc. Acad. Nat. Sci. Philadelphia, p. 104), and identical with the genus *Gnathograpsus* A. M.-Edw. 1868, is, at the present time, September 1905, represented by the following twelve species:—

1. *Ptychognathus glaber* Stimps. 1858. ♂.
2. " *pusillus* Heller 1865. ♂ ♀.
3. " *riedelii* A. M.-Edw. 1868. ♂ ♀.
- 3 a. " " var. *pilosa* de M. 1892. ♂.
4. " *pilipes* A. M.-Edw. 1868. ♂.
5. " *barbatus* A. M.-Edw. 1872. ♂ ♀.

6. *Ptychognathus intermedius* de M. 1879. ♂.
7. " *dentatus* de M. 1892. ♂ ♀.
8. " *spinicarpus* Ortm. 1894. ♂.
9. " *polleni* de M. 1895. ♂.
10. " *affinis* de M. 1895. ♂.
11. " *onyx* Alcock 1900. ♂.
12. " *andamanicus* Alcock 1900. ♀.

Of all these species the male is known, except of *Ptych. andamanicus* Alcock, which is, however, probably identical with *Ptych. riedelii* A. M.-Edw.; of five species only has the female been observed.

According to their outer appearance and physiognomy these 12 species may be divided into three natural sections. The first section represented by five species, viz. *Ptych. dentatus*, *spinicarpus*, *polleni*, *affinis*, and *onyx*, of which *Ptych. dentatus* is the typical form, is distinguished by the following characters:—The carapace is hardly broader than long, the regions usually quite distinct, as also the epigastric lobes. The three teeth of the antero-lateral margins are sharp and salient. Front prominent, laminar, straight, or nearly straight. Inner angle of the carpus of the chelipedes produced, in the male, to form a more or less long spine, except in *Ptych. dentatus*, in which the inner angle is acute, but not spiniform. Chelæ glabrous on their outer surface, except in *Ptych. onyx*, in which there is a tuft of hair in the finger-cleft and extending along the fixed finger. Ambulatory legs hairy, the anterior border of the merus with a subterminal spine.

The second section is composed of *Ptych. glaber*, *riedelii*, with its variety *pilosa*, and *Ptych. andamanicus*; *Ptych. riedelii* may be regarded as the type. The carapace of *Ptych. riedelii* and *andamanicus* is hardly broader than long, that of *glaber*, however, is distinctly broader than long. The upper surface is quite flat, much depressed, the regions are not or hardly indicated, and the epigastric lobes are wanting. There are two teeth behind the extraorbital angle, as in the two other sections, or one (*glaber*); the teeth are small, not very acute or distinct. Front prominent, laminar, slightly sinuous, furrowed transversely. Inner angle of the carpus of the chelipedes obtuse, rounded, or (in *Ptych. andamanicus*) pronounced, though not spiniform. A brush of stiffish hair at the tip of the fixed finger on its outer surface, except in *Ptych. glaber*; chelæ for the rest glabrous, except in *Ptych. riedelii* var. *pilosa*. Ambulatory legs hairy; subterminal tooth on the anterior border of the merus inconspicuous or blunt.

The third section is represented by four species, viz. *Ptych. pusillus*, *pilipes*, *barbatus*, and *intermedius*, of which *pusillus* may be regarded as the type. The carapace is decidedly broader than long, flat, though not much depressed. Regions more or less distinct, as also the epigastric lobes. Front not prominent, distinctly sinuous, and transversely ridged. The three antero-lateral teeth are not very conspicuous. Inner angle of the carpus

of the chelipedes obtuse, or little pronounced, never spiniform. Fingers, in the male, with a tuft of hair on their outer surface, proximally (*barbatus*, *pusillus*), or glabrous; in the latter case the palm is either smooth on its outer side (*pilipes*), or granulated (*intermedius*). Ambulatory legs more or less hairy, no sub-terminal spine on the anterior border of the meropodites.

Artificial key to the males of the Indo-Pacific species of the genus *Ptychognathus* Stimps.*

- | | |
|---|--|
| 1. Fingers glabrous on their outer side (proximally †) | 2. |
| 1. Both fingers, or one of them, with a tuft of hair on their outer surface, proximally | 3. |
| 2. Exognath of external maxillipedes, in the adult male, twice or more than twice as broad as the ischium ‡ | 4. |
| 2. Exognath less than twice as broad as the ischium | 5. |
| 4. Inner surface of the chelæ glabrous | 6. |
| 4. Inner surface of the palm with a tuft of hair; carpus with a small, acute tooth at the inner angle; second and third antero-lateral teeth of the carapace sharp, salient; epigastric lobes distinct | <i>dentatus</i> . |
| 6. Inner angle of the carpus obtuse or pronounced, but not spiniform; a brush of stiffish hair at the tip of the fixed finger on its outer surface; second and third antero-lateral teeth of the quite flat, much depressed carapace not salient, inconspicuous | { <i>riedelii</i> .
<i>andamanicus</i> §. |
| 6. Inner angle of the carpus produced to form a long spine; no brush of stiffish hair at the tip of the fixed finger on its outer surface; second and third antero-lateral teeth of the flat, though not particularly depressed carapace salient, sharp .. | <i>spinicarpus</i> .
7. |
| 5. Two teeth behind the extraorbital angle | |
| 5. One single, small tooth behind the extraorbital angle; inner angle of the carpus rounded; outer surface of the chelæ smooth; ambulatory legs with long hairs on both margins .. | <i>glaber</i> .
8. |
| 7. Outer surface of the chelæ smooth, towards the base of the immobile finger | |
| 7. Outer surface of the chelæ distinctly granulated; antero-lateral teeth of the carapace as little prominent as in <i>Ptych. riedelii</i> , general shape of the carapace as in <i>Ptych. pilipes</i> , and ambulatory legs, as in that species, very hairy | <i>intermedius</i> .
9. |
| 8. Inner angle of the carpus produced to form a short, sharp spine | |
| 8. Inner angle of the carpus obtuse; distance between the extra-orbital angles much shorter than the length of the carapace; epigastric lobes distinct; ambulatory legs very hairy | <i>pilipes</i> .
<i>polleni</i> . |
| 9. Distance between the extraorbital angles much shorter than the length of the carapace; epigastric lobes distinct | |

* *Ptych. andamanicus* Alcock is included in this key, though only the female is known, because this species is probably identical with *riedelii*, or in any case most closely related.

† The word "proximally" is added, because in *Ptych. riedelii* and *andamanicus* there is a small tuft of hair at the distal end of the immobile finger, externally.

‡ Only the young female of *andamanicus* is known. In it the breadth of the exognath is nearly twice that of the ischium; we may therefore conclude that in the adult male the exognath will be twice or more than twice as broad as the ischium, because, as a rule, the exognath is, in this genus, less broad in the female than in the male.

§ These two species are probably identical. The carpus of the chelipedes of *riedelii* has a tuft of hair on its outer angle, both in the male and in the female; in Alcock's description of *andamanicus* this character has not been mentioned. *Ptych. riedelii* has also been observed at Atjeh.

- | | |
|--|---|
| 9. Distance between the extraorbital angles as long as the length of the carapace; no epigastric lobes | <i>affinis.</i> |
| 3. Both fingers with a tuft of hair proximally | 10. |
| 3. A tuft of hair in the finger-cleft and extending along the fixed finger; carapace hardly broader than long, depressed; teeth of the antero-lateral border sharp and salient; inner angle of the wrist produced to form a long spine | <i>onyx.</i> |
| 10. Exognath of external maxillipedes, in the adult male, more than twice as broad as the ischium; epigastric lobes wanting; a brush of stiffish hair at the tip of the fixed finger externally | { <i>riedelii.</i>
var. <i>pilosa.</i> |
| 10. Exognath, in the adult male, not once and a half as broad as the ischium | 11. |
| 11. Upper surface of the carapace granulated near the antero-lateral margins; second and third antero-lateral teeth of the carapace not salient; epigastric lobes distinct; granulated ridge behind the frontal border distinctly separated from it in the middle | <i>pusillus.</i> |
| 11. Upper surface of the carapace, which is broader anteriorly than that of <i>pusillus</i> , not granulated near the antero-lateral margins; second and third antero-lateral teeth more salient than those of <i>pusillus</i> ; epigastric lobes distinct; granulated ridge behind the frontal margin contiguous to it in the middle line | <i>barbatus.</i> |

Artificial key to the known females of the species of
Ptychognathus.

- | | |
|---|---|
| 1. Carapace hardly broader than long, front prominent, nearly straight | 2. |
| 1. Carapace decidedly broader than long, front little prominent and distinctly sinuous | 3. |
| 2. Regions of the flat, though not particularly depressed carapace and epigastric lobes distinct; antero-lateral teeth of the carapace sharp and salient | <i>dentatus.</i> |
| 2. Regions of the much depressed and quite flat carapace hardly indicated; no epigastric lobes | { <i>riedelii.</i>
<i>andamanicus.</i> |
| 3. Upper surface of the carapace granulated near the antero-lateral margins; ridge behind the frontal margin distinctly separated from it in the middle; exognath of external maxillipedes distinctly less broad than the ischium | <i>pusillus.</i> |
| 3. Upper surface of the carapace, which is anteriorly broader than that of <i>pusillus</i> , not granulated near the antero-lateral margins; ridge behind the frontal margin contiguous to it in the middle; exognath of outer footjaws just as broad or very slightly broader than the ischium | <i>barbatus.</i> |

PALEMÓN (*EUPALEMÓN*) *LAR* Fabr. var. ? (Plate XVIII. figs. 7-19.)

One male and one female without eggs from a freshwater pool, Christmas Island.

During the two or three last decennaries several carcinologists have regarded a more or less large number of described species of the subgenus *Eupalemon* as synonyms or, at the utmost, as individual or local varieties of *Palemon* (*Eupalemon*) *lar* Fabr. (confer: de Man, in 'Notes from the Leyden Museum,' 1879, pp. 168-173; Ortmann, in 'Zoolog. Jahrbücher (Spengel),' v. Abth. f. Syst. 1890, p. 724; Coutière, in 'Annales Sciences Naturelles,' Zool. 8^{me} série, t. xii. 1900, p. 292, and other papers of the same authors). Several specimens of *Pal. lar* Fabr. from

different localities of the Indian Archipelago, described, in 1892, in my paper on the Decapod Crustacea collected by Prof. Max Weber, are lying before me, as also are specimens from my own collection. When the young male from the River Palopo on the island of Celebes (de Man, in Max Weber, Zool. Ergebnisse, ii. 1892, p. 447) is compared with the male from Christmas Island, a doubt occurs to me whether we are right in considering these two Prawns as belonging to one and the same species. The male from the River Palopo (Pl. XVIII. figs. 16-19) is certainly a typical example of *Pal. lar* Fabr., but in the male from Christmas Island, the size of which is even a little smaller, *all the legs have a much stouter shape*, and there are no doubt still other differences. Specimens of *Eupalemon*, presenting the same characters as this male from Christmas Island, have formerly been referred by me, and no doubt also by other authors (because this form is probably also widely distributed throughout the Indian Archipelago), to the "well-known" *Pal. lar* Fabr.; but it appears to be a question *whether this form may still be regarded as a variety or not*. I do not venture to decide this question at present, because the specimens are apparently young, but I wish to draw the attention of carcinologists to it, confining myself at present to describing the specimens from Christmas Island accurately.

These Prawns are, no doubt, young; the male is 62 mm. long from the tip of the rostrum to the end of the telson, the female 43 mm. The carapace of both is *smooth*. The lanceolate rostrum (Pl. XVIII. fig. 7) of the male is rather short, shorter than the peduncles of the internal antennæ, *reaching but a little beyond the penultimate joint of these peduncles*. The upper border, slightly arcuate above the eyes, is somewhat directed downward, though the acute tip extends horizontally forward; it carries eight equidistant teeth, that reach to the tip. *The first two teeth stand on the carapace*, the third just before the frontal margin, above the insertion of the eye-peduncles, and these teeth diminish a little in length from the second, that is the longest, to the last one. The distal half of the lower border carries *three* equidistant teeth that are smaller than those of the upper border, and the first of which is situated just below the antepenultimate tooth of the upper border; the acute tip of the 3rd is a little farther from the extremity of the rostrum than from the tip of the 2nd tooth. At the level of the 1st tooth of the lower margin the rostrum is *just as broad above as below the lateral carina*, and the height of the rostrum at its base is *a little larger* than its breadth below that carina. Hepatic and antennal spines as in typical specimens of *Pal. lar*. Of the two pairs of spinules on the upper surface of the telson, the anterior is inserted on the middle, the posterior midway between the anterior pair and the tip of the telson. The telson ends posteriorly in a sharp tooth; the inner of the two spines on either side projects half its length beyond the median tooth, whereas the outer spinule, barely half as long as the inner, reaches not so far backward as the median

tooth. The short flagellum of the internal antennæ, which is just as long as their peduncle, is serrulate internally, and coalesced for a very short distance, *i. e.* for $\frac{1}{9}$ of its length, with the outer flagellum.

The legs of the first pair reach with their chelæ beyond the antennal scales; the chela is *a little more than half as long* as the carpus.

The legs of the 2nd pair (figs. 8 and 9) are *unequal*, the left being a little larger than the other. The left leg (fig. 8), which is somewhat shorter than the body, projects more than half the carpus beyond the antennal scales. The cylindrical merus, that slightly thickens distally, is four times as long as thick. The carpus, which is *a little shorter* than the merus, has a *rather stout*, conical shape; it thickens considerably towards the distal end, appearing here *more than twice as thick* as at its base, when looked at from above, and its width at the distal end measures *two-fifths* of its length. The chela is somewhat longer than merus and carpus taken together. The palm is *nearly once and a half as long as the carpus*, and *one-fourth longer* than the fingers, which are a little curved inward, so that the inner border of the chela appears somewhat concave; the palm, *distinctly broader* than the carpus, is *somewhat broader than thick*, though but very little, the breadth in the middle being in proportion to its thickness as 15 : 13, so that it appears almost cylindrical. About at one-third of its length from the articulation the immobile finger is armed with a conical tooth (fig. 10), half as high as the finger is broad at this place; behind it is seen a smaller rounded tooth and, between the latter and the articulation, four or five extremely small and low rounded teeth. The dactylus appears, at its base, a little broader than the fixed finger (fig. 8), and is armed, just in the middle, with a slightly curved, conical tooth, which is *a little larger* than the foremost tooth of the index; opposite to it on the fixed finger is a small notch (fig. 10), that fits the tooth. Between this tooth and the articulation there are still five or six, *much smaller*, obtuse, somewhat unequal teeth. The tapering fingers therefore do not shut close together; between the foremost teeth and the tip the cutting-edge is sharp. The joints of this leg are everywhere covered with *innumerable minute, sharp spinules*, except on the usual, naked lines; these spinules are more crowded and a little larger on the outer and on the inner border of the palm and near the finger-cleft on the upper surface, whereas they are less numerous on the rest of the upper and on the lower surfaces. They are few in number on both sides of the fixed finger; on the outer margin of this finger they are also few in number, but larger than on the inner border of the palm. The outer side of the dactylus is thickly beset with slenderer, larger spinules, the sharp tip of which is curved upward, whereas the inner part of the upper and lower surface is nearly smooth. A few microscopical hairs occur on the outer and inner borders of the chela and of the other joints.